

CLAIMS

1. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R (Reshaping, Retiming, and Regeneration) relay is defined as a 3R section, the optical node device comprising:
 - 5 a storing unit which stores 3R section information corresponding to topology information of an optical network to which the optical node device itself belongs; and a determining unit which determines autonomously whether the optical node device itself is an optical node device that implements 3R relay when setting an optical path passing through the optical node device itself, with reference to the 3R section
 - 10 information stored in the storing unit which stores the 3R section information.
2. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device, being a source of a setting request for an optical path is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node, the optical node device comprising:
 - 15 a storing unit which stores 3R section information corresponding to topology information of an optical network to which the optical node device itself belongs;
 - 20 an identifying unit which identifies another optical node device which implements 3R relay among other optical node devices through which an optical path from the optical node device itself to the destination node passes with reference to the 3R section information stored in the storing unit, when the optical node device itself is the source node; and

a unit which requests 3R relay be implemented in the other optical node device identified by the identifying unit, when setting an optical path in which the optical node device itself is the source node.

5 3. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined a destination node, the optical node device comprising:

10 a storing unit which stores 3R section information corresponding to topology information of an optical network to which the optical node device itself belongs when the optical node device itself is an optical node device through which an optical path between the source node and the destination node passes; and

a determining unit which determines autonomously whether the optical node

15 device itself is an optical node device that implements 3R relay with reference to the 3R section information stored in the storing unit, when setting an optical path passing through the optical node device itself.

4. An optical node device according to claim 1 or claim 3, wherein when an optical

20 node device, being a source of a setting request for an optical path, is the source node, an optical node device at an end point of the optical path is the destination node, and the optical path is bi-directional, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, and when the optical path is a bi-directional optical path, the determining unit is

provided with a unit which decides which optical node device implements 3R relay in both the downstream optical path and the upstream optical path.

5. An optical node device according to claim 2, wherein when an optical node
5 device, being a source of a setting request for an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and the optical path is bi-directional, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical
10 path, and when the optical path is a bi-directional optical path, the identifying unit is provided with a unit which decides which optical node device implements 3R relay in both the downstream optical path and the upstream optical path.

6. An optical node device according to claim 1, claim 3, or claim 4, wherein an
15 optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as the destination node, and
20 when one optical node device is a 3R source node of any one of a plurality of different 3R sections overlapping on an optical path that passes through the one optical node device, and the one optical node device is not a 3R source node or 3R destination node of other 3R sections,

the determining unit is provided with:

a comparing unit which compares the number of 3R relay implementations for both the case where the one optical node device functions as a 3R source node and where the one optical node device does not function as a 3R source node, with reference to the 3R section information related to an optical path from the one optical node device to the 5 destination node; and

a unit which, when the number of 3R implementations in the case where the one optical node device functions as a 3R source node is less than the number of 3R implementations in the case where the one optical node device does not function as a 3R source node, decides that the one optical node device is an optical node device that 10 implements 3R relay based on a comparison result from the comparing unit.

7. An optical node device according to claim 2 or claim 5, wherein an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical 15 node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node, and

when one optical node device is a 3R source node of any one of a plurality of different 3R sections overlapping on an optical path that passes through the one optical 20 node device, and the one optical node device is not a 3R source node or 3R destination node of other 3R sections,

the identifying unit is provided with:

a comparing unit which compares the number of 3R relay implementations for both the case where the one optical node device functions as a 3R source node and where the one optical node device does not function as a 3R source node, with reference to the 25 destination node; and

3R section information related to an optical path from the one optical node device to the destination node; and

a unit which, when the number of 3R implementations in the case where the one optical node device functions as a 3R source node is less than the number of 3R

5 implementations in the case where the one optical node device does not function as a 3R source node, decides that the one optical node device is an optical node device that implements 3R relay based on a comparison result from the comparing unit.

8. An optical node device according to claim 1, claim 3, or claim 4, wherein an

10 optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node, and

when one optical node device is an optical node device corresponding to a 3R destination node, and is not a destination node,

15 the determining unit is provided with a unit which decides that the one optical node device is an optical node device that implements 3R relay by using the one optical node device as a 3R source node, and a next hop optical node device as a 3R destination node.

20 9. An optical node device according to claim 2 or claim 5, wherein an optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node, and

when one optical node device is an optical node device corresponding to a 3R

25 destination node, and is not a destination node,

the identifying unit is provided with a unit which decides that the one optical node device is an optical node device that implements 3R relay by using the one optical node device as a 3R source node, and a next hop optical node device as a 3R destination node.

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10. An optical node device according to claim 1, claim 3, or claim 4, wherein an optical node device at a start point of the 3R section is defined as a 3R source node, and when one optical node device does not belong to any one of 3R sections having a 3R source node on an optical path that passes through the one optical node device,

10 the determining unit is provided with a unit which decides that the one optical node device is an optical node device that implements 3R relay by using the one optical node device as a 3R source node, and a next hop optical node device of the one optical node device as a 3R destination node.

15 11. An optical node device according to claim 2 or claim 5, wherein an optical node device at a start point of the 3R section is defined as a 3R source node, and when one optical node device does not belong to any one of 3R sections having a 3R source node on an optical path that passes through the one optical node device, the identifying unit is provided with a unit which decides that the one optical node device is 20 an optical node device that implements 3R relay by using the one optical node device as a 3R source node, and a next hop optical node device of the one optical node device as a 3R destination node.

12. An optical node device according to claim 1, claim 3, or claim 4, further 25 comprising a unit which, when one optical node device is a 3R source node in an

upstream optical path, and is not a destination node, and the one optical node device is not a 3R destination node in the upstream optical path, transmits a message in order to transmit information to a previous hop optical node device in the upstream optical path that the previous hop optical node device is a 3R source node which uses the one optical
5 node device as a 3R destination node,

wherein the determining unit is provided with a unit which decides that the optical node device itself is a 3R source node in the upstream optical path with an optical node device which has sent the message as a 3R destination node when the optical node device itself receives the message in the upstream optical path.

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13. An optical node device according to claim 2 or claim 5, further comprising a unit which, when one optical node device is a 3R source node in an upstream optical path, and is not a destination node, and the one optical node device is not a 3R destination node in the upstream optical path, transmits a message in order to transmit
15 information to a previous hop optical node device in the upstream optical path that the previous hop optical node device is a 3R source node which uses the one optical node device as a 3R destination node,

wherein the identifying unit is provided with a unit which decides that the optical node device itself is a 3R source node in the upstream optical path with an optical
20 node device which has sent the message as a 3R destination node when the optical node device itself receives the message in the upstream optical path.

14. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an
25 optical node device at a start point of the 3R section is defined as a 3R source node, and

an optical node device at an end point of the 3R section is defined as a 3R destination node, the optical node device comprising:

a storing unit which stores information of a 3R section in which the optical node device itself is a 3R source node; and

- 5 a unit which, when the optical node device itself is not a destination node on receiving a message, contained in a setting request for an optical path, indicating that the optical node device itself is a 3R destination node, refers to the storing unit, and when the optical node device itself is a 3R source node in the optical path, determines that the optical node device itself is an optical node device that implements 3R relay, and
- 10 transmits a message to an optical node device, corresponding to a 3R destination node of a 3R section in an optical path in which the optical node device itself is a 3R source node, in order to transmit that the optical node device corresponding to the 3R destination node is a 3R destination node.

- 15 15. An optical node device according to claim 14, further comprising a unit which, when the optical node device itself is not a destination node on receiving the message, contained in the setting request for the optical path, indicating that the optical node device itself is the 3R destination node, refers to the storing unit, and when the optical node device itself is not a 3R source node in the optical path, determines that the optical node device itself is an optical node device that implements 3R relay as a 3R source node using a next hop optical node device as a 3R destination node, and transmits a message to the next hop optical node device in order to transmit that the next hop optical node device is a 3R destination node.
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16. An optical node device that switches an optical signal, wherein when a preset section in which data transmission is possible without 3R relay is a 3R section, an optical node device at a start point of the 3R section is a 3R source node, an optical node device at an end point of the 3R section is a 3R destination node, an optical node device, being a 5 source of a setting request of an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and the optical path is a bi-directional optical path, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical 10 path, the optical node device comprising:

a storing unit which stores information of a 3R section in which the optical node device itself is a 3R source node and a 3R destination node;

a unit which, when the optical node device itself is not a destination node on receiving a message, contained in an optical path setting request, indicating that the 15 optical node device itself is a 3R destination node in the downstream optical path, refers to the storing unit, and when the optical node device itself is a 3R source node in the downstream optical path, determines that the optical node device itself is an optical node device that implements 3R relay, and transmits a message to an optical node device corresponding to a 3R destination node of a 3R section in the downstream optical path in 20 which the optical node device itself is a 3R source node, in order to transmit that the optical node device corresponding to the 3R destination node is a 3R destination node;

and

a unit which determines that the optical node device itself is an optical node device that implements 3R relay in the upstream optical path on receiving a message, 25 contained in an optical path setting request, indicating that the optical node device itself

is a 3R source node in the upstream optical path and which, when the optical node device itself is not a destination node, refers to the storing unit, and when the optical node device itself is a 3R destination node in the upstream optical path, transmits a message to an optical node device corresponding to a 3R source node in the upstream optical path in 5 which the optical node device itself is a 3R destination node, in order to transmit that the optical node device corresponding to the 3R source node is a 3R source node.

17. An optical node device according to claim 16, further comprising:

a unit which, when the optical node device itself is not a destination node on 10 receiving the message, contained in the optical path setting request, indicating that the optical node device itself is the 3R destination node in the downstream optical path, refers to the storing unit, and when the optical node device itself is not a 3R source node in the downstream optical path, determines that the optical node device itself is an optical node device that implements 3R relay using the optical node device itself as a 3R source 15 node and a next hop optical node device in the downstream optical path as a 3R destination node, and transmits a message to the next hop optical node device in order to transmit that the next hop optical node device is a 3R destination node of the optical node device itself; and

a unit which determines that the optical node device itself is an optical node 20 device that implements 3R relay in the upstream optical path on receiving the message, contained in the optical path setting request, indicating that the optical node device itself is the 3R source node in the upstream optical path, and which when the optical node device itself is not a destination node, refers to the storing unit, and when the optical node device itself is not a 3R destination node in the upstream optical path, transmits a 25 message to a previous hop optical node device in the upstream optical path, in order to

transmit that the previous hop optical node device is a 3R source node using the optical node device itself as a 3R destination node.

18. A network control device that manages an optical network which is provided
5 with: a plurality of optical node devices that switch optical signals; and optical transmission paths connecting the plurality of optical node devices, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, the network control device comprising:

a storing unit which stores 3R section information corresponding to topology

10 information of the optical network; and

a unit which provides the 3R section information stored in the storing unit to an optical node device according to a request from the optical node device.

19. An optical node device that switches an optical signal, comprising an acquiring

15 unit which requests a network control device managing an optical network to which the optical node device itself belongs to provide 3R section information corresponding to topology information of the optical network, and acquires the 3R section information.

20. An optical node device according to claim 19, wherein the acquiring unit is

20 provided with a unit which selects and stores at least a part of information associated with the optical node device itself from the 3R section information acquired.

21. An optical node device that switches an optical signal, wherein a preset section

in which data transmission is possible without 3R relay is defined as a 3R section, the

25 optical node device comprising:

an acquiring unit which requests a network control device that manages an optical network to which the optical node device itself belongs, for 3R section information corresponding to topology information of the optical network to which the optical node device itself belongs and acquires the 3R section information; and

5 a unit which stores the 3R section information acquired by the acquiring unit, and advertises the 3R section information to other optical node devices.

22. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an

10 optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node, the optical node device comprising:

an acquiring unit which requests a network control device managing an optical network to which the optical node device itself belongs for 3R section information

15 corresponding to topology information of the optical network to which the optical node device itself belongs when the optical node device itself is a source node, and acquires the 3R section information; and

a unit which stores the 3R section information acquired by the acquiring unit, and transmits the 3R section information to other optical node devices contained in an
20 optical path up to the destination node when the optical node device itself is used as the source node.

23. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an

25 optical node device, being a source of a setting request for an optical path, is defined as a

source node, and an optical node device at an end point of the optical path is defined as a destination node, the optical node device comprising:

an acquiring unit which requests a network control device managing an optical network to which the optical node device itself belongs for 3R section information

5 corresponding to topology information of the optical network to which the optical node device itself belongs when the optical node device itself is a source node, and acquires the 3R section information;

an advertising unit which stores the 3R section information acquired by the acquiring unit, and advertises the 3R section information to other optical node devices;

10 a determining unit which determines whether an advertisement by the advertising unit is associated with an optical path that passes through the optical node device itself;

a unit which discards the advertisement when a determination result of the determining unit indicates that the advertisement is not associated with the optical path
15 that passes through the optical node device itself; and

a unit which stores contents of the advertisement when the determination result of the determining unit indicates that the advertisement is associated with the optical path which passes through the optical node device itself.

20 24. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined

as a source node, and an optical node device at an end point of the optical path is defined as a destination node, the optical node device comprising:

a storing unit which stores information of the number of hops H between the optical node device itself and a 3R destination node in a 3R section to which the optical

5 node device itself belongs; and

a determining unit which determines autonomously whether the optical node device itself implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs,

wherein the determining unit determines that 3R relay is implemented, if

10 $T > TH_T$, and $H < TH_H$, where T is the number of 3R trunks that the optical node device itself has, TH_T is a threshold value of the number of vacant 3R trunks, and TH_H is a threshold value of the number of hops up to the 3R destination node.

25. An optical network that is provided with an optical node device according to any

15 one of claim 1 through claim 17 and claim 19 through claim 24, or a network control device according to claim 18.

26. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

20 defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source node, an optical node device at an end point of the 3R section as a 3R destination node, an optical node device, being a source of a setting request for an optical path, as a source node, and an optical node device at an end point of the optical path as a destination node;

when one optical node device is a 3R source node of any one of a plurality of different 3R sections overlapping on an optical path that passes through the one optical node device, and the one optical node device does not correspond to a 3R source node or 3R destination node of other 3R sections, comparing the number of 3R implementations

- 5 for both the case where the one optical node device functions as a 3R source node and where the one optical node device does not function as a 3R source node, with reference to 3R section information related to an optical path from the one optical node device up to the destination node, and deciding that the one optical node device is an optical node device that implements 3R relay, when the number of 3R implementations is less in the
- 10 case where the one optical node device functions as a 3R source node than in the case where the one optical node device does not function as a 3R source node, based on a comparison result.

27. A decision method of a 3R relay implementation node in an optical node device
- 15 that switches an optical signal, the method comprising the steps of:

defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source node, an optical node device at an end point of the 3R section as a 3R destination node, an optical node device, being a source of a setting request for an optical path, as a source

20 node, and an optical node device at an end point of the optical path as a destination node; and

deciding that when one optical node device is an optical node device corresponding to a 3R destination node, and is not a destination node, the one optical node device is an optical node device that implements 3R relay using the one optical

node device as a 3R source node, and a next hop optical node device as a 3R destination node.

28. A decision method of a 3R relay implementation node in an optical node device

5 that switches an optical signal, the method comprising the steps of:

defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source node, an optical node device at an end point of the 3R section as a 3R destination node, an optical node device, being a source of a setting request for an optical path, as a source 10 node, and an optical node device at an end point of the optical path as a destination node; and

deciding that when one optical node device does not belong to any one of 3R sections having a 3R source node in an optical path which passes through the one optical node device, the one optical node device is an optical node device that implements 3R 15 relay using the one optical node device as a 3R source node, and a next hop optical node device of the one optical node device as a 3R destination node.

29. A decision method of a 3R relay implementation node in an optical node device

that switches an optical signal, the method comprising the steps of:

20 when a preset section in which data transmission is possible without 3R relay is a 3R section, an optical node device at a start point of the 3R section is a 3R source node, an optical node device at an end point of the 3R section is a 3R destination node, an optical node device, being a source of a setting request for an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and 25 the optical path is bi-directional, defining an optical path directed away from the source

node toward the destination node as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path;

when one optical node device is a 3R source node, but not a destination node in 5 the upstream optical path, and the one optical node device is not a 3R destination node in the upstream optical path, sending a message to a previous hop optical node device in the upstream optical path in order to transmit information that the previous hop optical node device is a 3R source node using the one optical node device as a 3R destination node; and

10 the optical node device receiving the message in the upstream optical path deciding that the optical node device itself is a 3R source node in the upstream optical path using an optical node device, being a sender of the message, as a 3R destination node.

15 30. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source node, and an optical node device at an end point of the 3R section as a 3R destination 20 node; and

an optical node device corresponding to a 3R source node stores 3R section information related to the optical node device itself, referring to the 3R section information when the optical node device corresponding to a 3R source node is not a destination node on receiving a message, contained in a setting request for an optical 25 path, indicating that the optical node device corresponding to a 3R source node is a 3R

destination node, determining that the optical node device itself is an optical node device that implements 3R relay when the optical node device itself is a 3R source node in the optical path, and sending a message to an optical node device corresponding to a 3R destination node of a 3R section in an optical path in which the optical node device itself 5 is a 3R source node in order to transmit that the optical node device corresponding to the 3R destination node is a 3R destination node.

31. A decision method of a 3R relay implementation node according to claim 30, further comprising the steps of:

10 referring to the 3R section information when the optical node device itself is not a destination node on receiving the message, contained in the setting request for the optical path, that the optical node device itself is the 3R destination node;

determining that the optical node device itself is an optical node device that implements 3R relay as a 3R source node using a next hop optical node device as a 3R

15 destination node when the optical node device itself is not a 3R source node in the optical path; and

transmitting a message to the next hop optical node device in order to transmit that the next hop optical node device is a 3R destination node.

20 32. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

when a preset section in which data transmission is possible without 3R relay is a 3R section, an optical node device at a start point of the 3R section is a 3R source node, an optical node device at an end point of the 3R section is a 3R destination node, an

25 optical node device, being a source of a setting request for an optical path, is a source

node, an optical node device at an end point of the optical path is a destination node, and the optical path is bi-directional, defining an optical path directed away from the source node toward the destination node as a downstream optical path, and an optical path directed away from the destination node toward the source node as an upstream optical

5 path;

storing information of a 3R section in which an optical node device is a 3R source node and a 3R destination node, and when the optical node device itself is not a destination node on receiving a message, contained in a setting request for an optical path, indicating that the optical node device itself is a 3R destination node in the

10 downstream optical path, referring to the information of the 3R section, and when the optical node device itself is a 3R source node in the downstream optical path, determining that the optical node device itself is an optical node device that implements 3R relay, and transmitting a message to an optical node device corresponding to a 3R destination node of a 3R section in the downstream optical path in which the optical node 15 device itself is a 3R source node, in order to transmit that the optical node device corresponding to the 3R destination node is a 3R destination node, and

determining that the optical node device itself is an optical node device that

implements 3R relay in the upstream optical path on receiving a message, contained in a setting request for an optical path, indicating that the optical node device itself is a 3R

20 source node in the upstream optical path, and when the optical node device itself is not a destination node, referring to the information of the 3R section, and when the optical node device itself is a 3R destination node in the upstream optical path, transmitting a message to an optical node device corresponding to a 3R source node in the upstream optical path in which the optical node device itself is a 3R destination node, in order to

transmit that the optical node device corresponding to the 3R source node is a 3R source node.

33. A decision method of a 3R relay implementation node according to claim 32,
 - 5 wherein the optical node device itself refers to the information of the 3R section when the optical node device itself is not a destination node on receiving the message, contained in the setting request for the optical path, indicating that the optical node device itself is a 3R destination node in the downstream optical path, and when the optical node device itself is not a 3R source node in the downstream optical path,
 - 10 determines that the optical node device itself is an optical node device that implements 3R relay using the optical node device itself as a 3R source node by using a next hop optical node device in the downstream optical path as a 3R destination node, and transmits a message to the next hop optical node device to transmit that the next hop optical node device is a 3R destination node of the optical node device itself, and
 - 15 determines that the optical node device itself is an optical node device that implements 3R relay in the upstream optical path on receiving the message, contained in the setting request for the optical path, indicating that the optical node device itself is a 3R source node in the upstream optical path, and when the optical node device itself is not a destination node, refers to the 3R section information, and when the optical node
 - 20 device itself is not a 3R destination node in the upstream optical path, transmits a message to a previous hop optical node device in the upstream optical path, to transmit that the previous hop optical node device is a 3R source node using the optical node device itself as a 3R destination node.

34. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source

5 node, an optical node device at an end point of the 3R section as a 3R destination node, an optical node device, being a source of a setting request for an optical path, as a source node, and an optical node device at an end point of the optical path as a destination node; and

deciding that one optical node device is an optical node device that implements

10 3R relay, if $T > TH_T$ and $H < TH_H$, where H is the number of hops between the one optical node device and a 3R destination node in a 3R section to which the one optical node device belongs, T is the number of 3R trunks with which the one optical node device is provided, TH_T is a threshold value of the number of vacant 3R trunks, and TH_H is a threshold value of the number of hops up to the 3R destination node.

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35. An optical node device comprising a switching unit which switches an optical signal, wherein a preset section in which data transmission is possible without 3R (Reshaping, Retiming and Regenerating) relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node 20 device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node, and wherein the setting request for the optical path contains labels for specifying wavelengths to be used in order from the source node at the time of switching

from the source node to the destination node, and the labels are deleted one by one each time a wavelength is set, and

the switching unit is provided with a wavelength conversion unit or a 3R relay unit, and

5 the optical node device further comprises:

a unit which stores information of the number of hops H between the optical node device itself and a 3R destination node of a 3R section to which the optical node device itself belongs; and

a determining unit which determines autonomously whether the optical node

10 device itself implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs, and

the determining unit determines that 3R relay is implemented if $T > TH_T$ and $(H < TH_H \text{ and } L < TH_L)$, where T is the number of trunks provided in the wavelength conversion unit or the 3R relay unit, TH_T is a threshold value of the number of vacant

15 trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

36. An optical node device comprising a switching unit which switches an optical

20 signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an 25 end point of the optical path is defined as a destination node, and

the setting request for the optical path contains labels for specifying wavelengths to be used in order from the source node at the time of switching from the source node to the destination node, and the labels are deleted one by one each time a wavelength is used, and

5 the switching unit is provided with a wavelength conversion unit or a 3R relay unit, and

the optical node device further comprises:

a unit which stores information of the number of hops H between the optical node device itself and a 3R destination node of a 3R section to which the optical node

10 device itself belongs; and

a determining unit which determines autonomously whether the optical node device itself implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs, and

the determining unit determines that 3R relay is implemented if $T > TH_T$ and

15 $(H < TH_H \text{ or } L < TH_L)$, where T is the number of trunks provided in the wavelength conversion unit or the 3R relay unit, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

20

37. An optical node device according to claim 35 or claim 36, further comprising a unit which determines that the optical node device itself does not implement 3R relay regardless of a result determined by the determining unit when the optical node device itself belongs to a 3R section in which a 3R destination node is the destination node.

38. An optical node device comprising a switching unit which switches an optical signal, wherein when a preset section in which data transmission is possible without 3R relay is a 3R section, an optical node device at a start point of the 3R section is a 3R source node, an optical node device at an end point of the 3R section is a 3R destination node, an optical node device, being a source of a setting request for an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and the optical path is bi-directional, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, and

the setting request for the optical path contains labels for specifying wavelengths to be used in order from the source node at the time of switching from the source node to the destination node, and the labels are deleted one by one each time a wavelength is set, and

15 the switching unit is provided with a wavelength conversion unit or a 3R relay unit, and

the optical node device further comprises:

a unit which stores information of the number of hops H between the optical node device itself and a 3R destination node of a 3R section to which the optical node

20 device itself belongs in the upstream optical path; and

· a determining unit which determines autonomously whether the optical node device itself implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs in the upstream optical path, and

the determining unit determines that 3R relay is implemented if $T > TH_T$ and $(H < TH_H \text{ and } L > TH_L)$, where T is the number of trunks provided in the wavelength conversion unit or the 3R relay unit, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

39. An optical node device comprising a switching unit which switches an optical signal, wherein when a preset section in which data transmission is possible without 3R relay is a 3R section, an optical node device at a start point of the 3R section is a 3R source node, an optical node device at an end point of the 3R section is a 3R destination node, an optical node device, being a source of a setting request for an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and the optical path is bi-directional, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, and

the setting request for the optical path contains labels for specifying wavelengths to be used in order from the source node at the time of switching from the source node to the destination node, and the labels are deleted one by one each time a wavelength is set, and

the switching unit is provided with a wavelength conversion unit or a 3R relay unit, and

the optical node device further comprises:

a unit which stores information of the number of hops H between the optical node device itself and a 3R destination node of a 3R section to which the optical node device itself belongs in the upstream optical path; and

5 a determining unit which determines autonomously whether the optical node device itself implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs in the upstream optical path, and

the determining unit determines that 3R relay is implemented if $T > TH_T$ and $(H < TH_H \text{ or } L > TH_L)$, where T is the number of trunks provided in the wavelength conversion unit or the 3R relay unit, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

15 40. An optical node device according to claim 38 or claim 39, further comprising a unit which determines that the optical node device itself does not implement 3R relay regardless of a result determined by the determining unit when the optical node device itself belongs to a 3R section in which a 3R destination node is the destination node.

20 41. An optical network constructed using an optical node device according to any one of claim 35 through claim 40.

42. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source node, an optical node device at an end point of the 3R section as a 3R destination node, an optical node device, being a source of a setting request for an optical path, as a source node, and an optical node device at an end point of the optical path as a destination node;

5 deleting labels, contained in the setting request for the optical path, for specifying wavelengths to be used in order from the source node at the time of switching from the source node to the destination node, one by one each time a wavelength is used;

storing information of the number of hops H between the optical node device

10 and a 3R destination node of a 3R section to which the optical node device belongs; and when determining autonomously whether the optical node device implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device belongs, determining that 3R relay is implemented if $T > TH_T$ and $(H < TH_H \text{ and } L < TH_L)$, where T is the number of trunks having a

15 function to perform wavelength conversion or 3R relay, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

20 43. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

defining a preset section in which data transmission is possible without 3R relay as a 3R section, an optical node device at a start point of the 3R section as a 3R source node, an optical node device at an end point of the 3R section as a 3R destination node,

an optical node device, being a source of a setting request for an optical path, as a source node, and an optical node device at an end point of the optical path as a destination node;

deleting labels, contained in the setting request for the optical path, for specifying wavelengths to be used in order from the source node at the time of switching

5 from the source node to the destination node, one by one each time a wavelength is used;

storing information of the number of hops H between the optical node device and a 3R destination node of a 3R section to which the optical node device belongs; and

when determining autonomously whether the optical node device implements

3R relay of an optical signal transmitted from a 3R source node in the 3R section to

10 which the optical node device belongs, determining that 3R relay is implemented if

$T > TH_T$ and $(H < TH_H \text{ or } L < TH_L)$, where T is the number of trunks having a function to perform wavelength conversion or 3R relay, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of

15 the number of the remaining labels.

44. A decision method of a 3R relay implementation node according to claim 42 or claim 43, wherein when the optical node device itself belongs to a 3R section in which a 3R destination node is the destination node, it is determined that the optical node device

20 itself does not implement 3R relay regardless of a determination result.

45. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

when a preset section in which data transmission is possible without 3R relay is

25 a 3R section, an optical node device at a start point of the 3R section is a 3R source node,

an optical node device at an end point of the 3R section is a 3R destination node, an optical node device, being a source of a setting request for an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and the optical path is bi-directional, defining an optical path directed away from the source

5 node toward the destination node as a downstream optical path, and an optical path directed away from the destination node toward the source node as an upstream optical path;

deleting labels, contained in the setting request for the optical path, for specifying wavelengths to be used in order from the source node at the time of switching

10 from the source node to the destination node, one by one each time a wavelength is set;

storing information of the number of hops H between the optical node device itself and a 3R destination node of a 3R section to which the optical node device itself belongs in the upstream optical path; and

when determining autonomously whether the optical node device itself

15 implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs in the upstream optical path, determining that 3R relay is implemented if $T > TH_T$ and $(H < TH_H \text{ and } L > TH_L)$, where T is the number of trunks having a function to perform wavelength conversion or 3R relay, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold 20 value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

46. A decision method of a 3R relay implementation node in an optical node device that switches an optical signal, the method comprising the steps of:

when a preset section in which data transmission is possible without 3R relay is a 3R section, an optical node device at a start point of the 3R section is a 3R source node, an optical node device at an end point of the 3R section is a 3R destination node, an optical node device, being a source of a setting request for an optical path, is a source node, an optical node device at an end point of the optical path is a destination node, and the optical path is bi-directional, defining an optical path directed away from the source node toward the destination node as a downstream optical path, and an optical path directed away from the destination node toward the source node as an upstream optical path;

10 deleting labels, contained in the setting request for the optical path, for specifying wavelengths to be used in order from the source node at the time of switching from the source node to the destination node, one by one each time a wavelength is set; storing information of the number of hops H between the optical node device itself and a 3R destination node of a 3R section to which the optical node device itself

15 belongs in the upstream optical path; and

when determining autonomously whether the optical node device itself implements 3R relay of an optical signal transmitted from a 3R source node in the 3R section to which the optical node device itself belongs in the upstream optical path, determining that 3R relay is implemented if $T > TH_T$ and $(H < TH_H \text{ or } L > TH_L)$, where

20 T is the number of trunks having a function to perform wavelength conversion or 3R relay, TH_T is a threshold value of the number of vacant trunks, TH_H is a threshold value of the number of hops up to the 3R destination node, L is the number of remaining labels, and TH_L is a threshold value of the number of the remaining labels.

47. A decision method of a 3R relay implementation node according to claim 45 or claim 46, wherein when the optical node device itself belongs to a 3R section in which a 3R destination node is the source node, it is determined that the optical node device itself does not implement 3R relay regardless of a determination result.

5

48. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R (Reshaping, Retiming, and Regenerating) relay is defined as a 3R section, the optical node device comprising:

a detecting unit which detects deterioration in the state of an optical signal that

10 reaches the optical node device itself;

a transmitting unit which, when a detection result from the detecting unit

indicates signal deterioration, transmits a 3R relay request to an adjacent optical node device corresponding to one hop before the optical node device itself; and

a unit which, when the optical node device itself receives a 3R relay request

15 from the transmitting unit of a next hop adjacent optical node device, implements 3R relay of an optical signal that reaches the optical node device itself.

49. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, the
20 optical node device comprising:

a detecting unit which detects deterioration in the state of an optical signal that

reaches the optical node device itself; and

a unit which, when a detection result from the detecting unit indicates signal

deterioration, implements 3R relay of an optical signal that reaches the optical node

25 device itself.

50. An optical node device which sets an optical path for other optical node devices contained in a route from the optical node device itself to a destination node which is defined as an optical node device at an end point of the optical path, one hop at a time in 5 order from a next hop adjacent optical node device, the optical node device comprising:

10 a transmitting unit which transmits an optical test signal each time an optical path is set for the other optical node devices contained in the route from the optical node device itself to the destination node one hop at a time in order from the next hop adjacent optical node device;

15 a receiving unit which, each time the optical test signal is transmitted to the other optical node devices contained in the route to the destination node one hop at a time in order from the next hop adjacent optical node device by the transmitting unit, receives a report of deterioration in the state of the optical test signal from another optical node device at the farthest end receiving the optical test signal; and

20 a unit which, when the deterioration in the state of the optical test signal based on the report received by the receiving unit satisfies a predetermined deterioration condition, requests another optical node device corresponding to one hop before the other optical node device at the farthest end to implement 3R relay, and

25 the other optical node device that is requested to implement 3R relay is provided with:

 a transmission unit which transmits an optical test signal to the other optical node devices contained in a route to the destination node each time an optical path is set one hop at a time in order from a next hop adjacent optical node device;

 a reception unit which, each time the optical test signal is transmitted to the other optical node devices contained in the route to the destination node one hop at a time

in order from the next hop adjacent optical node device by the transmission unit, receives a report of deterioration in the state of the optical test signal from another optical node device at the farthest end receiving the optical test signal; and

a unit which, when the deterioration in the state of the optical test signal based

- 5 on the report received by the reception unit satisfies a predetermined deterioration condition, requests another optical node device corresponding to one hop before the other optical node device at the farthest end to implement 3R relay.

51. An optical node device that switches an optical signal, wherein a preset section

- 10 in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined
- 15 as a destination node, the optical node device comprising:

a unit which stores a value Q, preset for each link based on optical signal deterioration characteristics in a link between the optical node device itself and an adjacent node;

- 20 a unit which, when the optical node device itself is a source node, transmits an initial value P of a minuend to a next hop adjacent optical node device;

a calculating unit which, when the optical node device itself receives from a previous hop adjacent optical node device, the initial value P or a minuend value P', which has already been reduced from the initial value P, calculates (P-Q) or (P'-Q);

- 25 a unit which compares a calculated result of the calculating unit with a threshold value, and when the calculated result is greater than the threshold value, transmits the

calculated result to the next hop adjacent optical node device, and when the calculated result is less than or equal to the threshold value, implements 3R relay of an optical signal that reaches the optical node device itself; and

5 a unit which, when the optical node device itself is not the destination node of an optical path to which the value of the minuend is transmitted, transmits the initial value P of the minuend to the next hop adjacent optical node device using the optical node device itself as a 3R source node.

52. An optical node device that switches an optical signal, wherein a preset section 10 in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined 15 as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, the optical node device comprising:

20 a detecting unit which detects deterioration in the state of an optical signal in the upstream optical path that reaches the optical node device itself;

a unit which, when a detection result from the detecting unit indicates signal deterioration, transmits a 3R relay implementation request to an adjacent optical node device corresponding to a next hop of the optical node device itself; and

25 a unit which, when the optical node device itself receives a 3R relay implementation request from a previous hop adjacent optical node device, implements

3R relay of an optical signal in the upstream optical path that reaches the optical node device itself.

53. An optical node device that switches an optical signal, wherein a preset section
5 in which data transmission is possible without 3R relay is defined as a 3R section, an
optical node device at a start point of the 3R section is defined as a 3R source node, an
optical node device at an end point of the 3R section is defined as a 3R destination node,
an optical node device, being a source of a setting request for an optical path, is defined
as a source node, an optical node device at an end point of the optical path is defined as a
10 destination node, an optical path directed away from the source node toward the
destination node is defined as a downstream optical path, and an optical path directed
away from the destination node toward the source node is defined as an upstream optical
path, the optical node device comprising:

15 a detecting unit which detects deterioration in the state of an optical signal in the
upstream optical path that reaches the optical node device itself; and
a unit which, when a detection result from the detecting unit indicates signal
deterioration, implements 3R relay of an optical signal in the upstream optical path that
reaches the optical node device itself.

20 54. An optical node device that switches an optical signal, wherein a preset section
in which data transmission is possible without 3R relay is defined as a 3R section, an
optical node device at a start point of the 3R section is defined as a 3R source node, an
optical node device at an end point of the 3R section is defined as a 3R destination node,
an optical node device, being a source of a setting request for an optical path, is defined
25 as a source node, an optical node device at an end point of the optical path is defined as a

destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, the optical node device comprising:

- 5 a unit which, when the optical node device itself is a source node, sets an optical path for other optical node devices contained in a route to the destination node one hop at a time in order from a next hop adjacent optical node device;
- a unit which, when an optical path is set in the optical node device itself and when the optical node device itself is not a source node, transmits an optical test signal to
- 10 the upstream optical path;
- a unit which, when the optical node device itself is a source node, receives the optical test signal, and informs a sender of the optical test signal of a report of deterioration in the state of the optical test signal;
- a unit which, when the optical node device itself is a sender optical node device
- 15 of an optical test signal, if the deterioration in the state of the optical test signal based on the report satisfies a predetermined deterioration condition, implements 3R relay of an optical signal from the upstream optical path that reaches the optical node device itself; and
- a unit which, when the optical node device itself is an optical node device that
- 20 implements 3R relay in the upstream optical path, sets an optical path for the other optical node devices contained in a route from the optical node device itself to the destination node one hop at a time in order from a next hop adjacent optical node device, receives an optical test signal, and informs a sender of the optical test signal of a report of deterioration in the state of the optical test signal.

55. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node,

5 an optical node device, being a source of a setting request for an optical path, is defined as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical

10 path, the optical node device comprising:

14 a unit which stores a value q , preset for each link based on optical signal deterioration characteristics in a link between the optical node device itself and an adjacent node;

15 a unit which, when the optical node device itself is a source node, transmits an initial value p of an augend to a next hop adjacent optical node device;

19 a calculating unit which, when the optical node device itself receives from a previous hop adjacent optical node device, the initial value p or an augend value p' , which has already been increased from the initial value p , calculates $(p+q)$ or $(p'+q)$;

20 a unit which compares a calculated result of the calculating unit with a threshold value, and when the calculated result is less than the threshold value, transmits the calculated result to a next hop adjacent optical node device, and when the calculated result is greater than or equal to the threshold value, implements 3R relay of an optical signal that reaches the optical node device itself; and

24 a unit which, when the optical node device itself is not the destination node of an optical path to which the value of the augend is transmitted, transmits the initial value p

of the value of the augend to the next hop adjacent optical node device using the optical node device itself as a 3R destination node in the upstream optical path.

56. An optical network constructed using an optical node device according to any

5 one of claim 48 through claim 55.

57. An optical path setting method which, when a preset section in which data

transmission is possible without 3R relay is defined as a 3R section, an optical node

device at a start point of the 3R section is defined as a 3R source node, an optical node

10 device, being a source of a setting request for an optical path, is defined as a source node,

and an optical node device at an end point of the optical path is defined as a destination

node, sets an optical path for optical node devices contained in a route from the source

node to the destination node one hop at a time in order from a next hop adjacent optical

node device of the source node, the method comprising:

15 a first step of transmitting an optical test signal from an optical node device,

being a source node, each time an optical path, is set for the optical node devices

contained in the route to the destination node one hop at a time in order from the next

20 hop adjacent optical node device of the optical node device, being the source node;

a second step in which, each time the optical test signal is transmitted in the first

step to the optical node devices contained in the route to the destination node one hop at

a time in order from the next hop adjacent optical node device of the optical node device,

being the source node, the optical node device, being the source node, receives a report

of deterioration in the state of the optical test signal from an optical node device at the

farthest end that receives the optical test signal;

a third step in which, when the deterioration in the state of the optical test signal based on the report received in the second step satisfies a predetermined deterioration condition, the optical node device, being the source node, requests an optical node device one hop before the optical node device at the farthest end to implement 3R relay;

5 a fourth step in which, each time the optical path is set for the other optical node devices contained in the route to the destination node one hop at a time in order from the next hop adjacent optical node device, the optical node device that is requested to implement 3R relay transmits an optical test signal;

10 a fifth step in which, each time the optical test signal is transmitted to the other optical node devices contained in the route to the destination node, one hop at a time in order from the next hop adjacent optical node device in the fourth step, the optical node device that is requested to implement 3R relay receives a report of deterioration in the state of the optical test signal from the other optical node device at the farthest end which receives the optical test signal; and

15 a sixth step in which, when the deterioration in the state of the optical test signal based on the report received in the fifth step satisfies a predetermined deterioration condition, the optical node device that is requested to implement 3R relay requests another optical node device one hop before the other optical node device at the farthest end to implement 3R relay.

20

58. A 3R relay implementation node setting method in an optical node device that switches an optical signal, the method comprising:

25 a step in which a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R

section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, as a source node, and an optical node device at an end point of the optical path is defined as a destination node;

a step in which each optical node device stores a value Q, preset for each link

5 based on optical signal deterioration characteristics in a link between the optical node device itself and an adjacent node;

a step in which an optical node device, being a source node, transmits an initial value P of a minuend to a next hop adjacent optical node device; and

a step in which each optical node device calculates $(P-Q)$ or $(P'-Q)$ when the

10 optical node device itself receives from a previous hop adjacent optical node device, the initial value P or a minuend value P' , which has already been reduced from the initial value P, compares a calculated result with a threshold value, and when the calculated result is greater than the threshold value, transmits the calculated result to the next hop adjacent optical node device, and when the calculated result is less than or equal to the

15 threshold value, implements 3R relay of an optical signal that reaches each optical node device, and when each optical node device is not a destination node of an optical path to which the value of the minuend is transmitted, transmits the initial value P of the minuend to the next hop adjacent optical node device using each optical node device as a

3R source node.

20

59. An optical path setting method, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source

node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, the

5 method comprising the steps of:

a seventh step in which an optical node device, being a source node, sets an optical path for other optical node devices contained in a route to the destination node one hop at a time in order from a next hop adjacent optical node device;

an eighth step in which an optical node device that is not the source node

10 transmits an optical test signal to the upstream optical path when an optical path is set in the optical node device itself;

a ninth step in which the optical node device, being a source node, receives the optical test signal, and gives notification to a sender of the optical test signal of a report of deterioration in the state of the optical test signal;

15 a tenth step in which an optical node device, being the sender of the optical test signal, implements 3R relay of an optical signal in the upstream optical path that reaches the optical node device itself when the deterioration in the state of the optical test signal based on the notification satisfies a predetermined deterioration condition; and

an eleventh step in which the optical node device that implements 3R relay in

20 the upstream optical path sets an optical path for the other optical node devices contained in a route from the optical node device itself to the destination node one hop at a time in order from a next hop adjacent optical node device, receives an optical test signal, and informs a sender of the optical test signal of report of deterioration in the state of the optical test signal.

60. A 3R relay implementation node setting method in an optical node device that switches an optical signal, the method comprising:

a step in which a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node;

10 a step in which each optical node device stores a value q , preset for each link based on optical signal deterioration characteristics in a link between the optical node device itself and an adjacent node;

a step in which an optical node device, being a source node, sends an initial value p of an augend to a next hop adjacent optical node device; and

15 a step in which each optical node device calculates $(p+q)$ or $(p'+q)$ when the optical node device itself receives from a previous hop adjacent optical node device, the initial value p or an augend value p' , which has already been increased from the initial value p , compares a calculated result with a threshold value, and when the calculated result is less than the threshold value, transmits the calculated result to the next hop adjacent optical node device, and when the calculated result is greater than or equal to the threshold value, implements 3R relay of an optical signal that reaches the optical node device itself, and when each optical node device is not the destination node of an optical path to which the value of the augend is transmitted, transmits the initial value p of the augend to the next hop adjacent optical node device using each optical node device as a 3R destination node in the upstream optical path.

61. A network control device that manages an optical network provided with a plurality of optical node devices that switch optical signals, and optical transmission paths that connect the plurality of optical node devices, wherein a preset section in which data transmission is possible without 3R (Reshaping, Retiming and Regenerating) relay 5 is defined as a 3R section, and an optical node device at a start point of the 3R section is defined as a 3R source node, the network control device comprising:

- a topology information storage unit which stores topology information of the optical network;
- a generating unit which generates in the topology information, estimate 10 information of a 3R section in which a specified optical node device is a 3R source node based on input information of the number of hops;
- a changing unit which changes part or the whole of the estimate information of the 15 3R section in the topology information generated by the generating unit, based on an input instruction; and
- a unit which informs information of a 3R section in the topology information, changed by the changing unit, to the optical node device.

62. A maintenance-staff device which, when a preset section in which data transmission is possible without 3R relay is defined as a 3R section, and an optical node 20 device at a start point of the 3R section is defined as a 3R source node, supplies input information of the number of hops to a network control device that manages an optical network provided with a plurality of optical node devices that switch optical signals, and optical transmission paths that connect the plurality of optical node devices, and generates in topology information, estimate information of a 3R section in which an 25 optical node device specified is a 3R source node based on the input information of the

number of hops, wherein the information of the number of hops is an estimated value of the number of hops of a 3R section, the maintenance-staff device comprising:

a generating unit which generates the estimated value of the number of hops;

a unit which stores topology information of the optical network together with

5 optical fiber type information and wavelength band information used in the optical network; and

a table in which the relationship between the optical fiber type and wavelength band and degree of deterioration of an optical signal per unit section is stored, and

wherein the generating unit generates the estimated value of the number of hops

10 with reference to the optical fiber type information and the wavelength band information in the topology information, and the optical fiber type, the wavelength band, and the degree of deterioration of an optical signal per unit section, stored in the table.

63. A network control device that manages an optical network provided with a

15 plurality of optical node devices that switch optical signals, and optical transmission paths that connect the plurality of optical node devices, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, and an optical node device at a start point of the 3R section is defined as a 3R source node, the network control device comprising:

20 a topology information storage unit which stores topology information of the optical network;

a generating unit which generates in the topology information, estimate information of a 3R section in which an optical node device specified is a 3R source node based on input information of the number of hops;

an instructing unit which instructs the optical node device to set an optical test path in a section of the optical network corresponding to the estimate information of the 3R section in the topology information generated by the generating unit;

a collecting unit which collects a measurement result of degree of optical signal

5 deterioration due to the optical test path set by the optical node device instructed by the instructing unit;

a changing unit which changes part or all of the estimate information of the 3R section in the topology information generated by the generating unit based on the measurement result of the degree of optical signal deterioration collected by the

10 collecting unit; and

a unit which informs the optical node device of information of a 3R section in the topology information changed by the changing unit.

64. An optical node device which, when a preset section in which data transmission

15 is possible without 3R relay is defined as a 3R section, and an optical node device at a start point of the 3R section is defined as a 3R source node, informs a network control device of a measurement result of degree of optical signal deterioration due to an optical test path, the network control device managing an optical network provided with: a plurality of optical node devices that switch optical signals; and optical transmission

20 paths that connect the plurality of optical node devices, generating in topology information, estimate information of a 3R section in which an optical node device specified is a 3R source node based on input information of the number of hops, giving an instruction to the optical node device to set the optical test path in a section of the optical network corresponding to the estimate information of the 3R section in the

25 generated topology information, collecting the measurement result of the degree of

optical signal deterioration due to the optical test path set by the optical node device by the instruction, changing part or all of the estimate information of the 3R section in the topology information generated based on the measurement result of the degree of optical signal deterioration collected, and informs changed information of the 3R section in the

5 topology information to the optical node device, the optical node device comprising:

a setting unit which sets an optical test path as instructed by the network control device;

a measuring unit which measures the degree of optical signal deterioration of the optical test path set by the setting unit; and

10 a unit which informs the network control device of a measurement result by the measuring unit.

65. A network control device that manages an optical network provided with a plurality of optical node devices that switch optical signals, and optical transmission

15 paths that connect the plurality of optical node devices, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, the network control device comprising:

a topology information storage unit which stores topology information of the optical network;

20 a 3R section information storage unit which stores 3R sections set in the optical network, corresponding to the topology information;

a collecting unit which collects traffic demand information in the optical network; and

a unit which informs a maintenance-staff of sections in which 3R section

25 information has not been generated, among sections in which traffic demand is increased,

based on the traffic demand information collected by the collecting unit, with reference to information from the 3R section information storage unit.

66. A network control device that manages an optical network provided with a plurality of optical node devices that switch optical signals, and optical transmission paths that connect the plurality of optical node devices, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, the network control device comprising:

a topology information storage unit which stores topology information of the

10 optical network;

a 3R section information storage unit which stores 3R sections set in the optical network, corresponding to the topology information;

a collecting unit which collects traffic demand information in the optical network; and

15 a unit which generates new 3R section information of sections in which 3R section information has not been generated, among sections in which traffic demand is increased, based on the traffic demand information collected by the collecting unit, with reference to the 3R section information storage unit.

20 67. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, and an optical node device at an end point of the 3R section is defined as a 3R destination node, the optical node device comprising:

a detecting unit which detects deterioration in the state of an optical signal that reaches the optical node device itself;

a notifying unit which, when a detection result from the detecting unit indicates signal deterioration, notifies an adjacent optical node device one hop before the optical node device itself that the adjacent optical node device is a 3R destination node, and also a 3R source node of a next 3R section;

a unit which, when the optical node device itself receives notification from the notifying unit of a next hop adjacent optical node device, recognizes that the optical node device itself is a 3R destination node, and also a 3R source node of a next 3R section;

10 and

an updating unit which updates information of a 3R section the optical node device itself stores based on a recognition result.

68. An optical node device that switches an optical signal, wherein a preset section

15 in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, and an optical node device at an end point of the 3R section is defined as a 3R destination node, the optical node device comprising:

a detecting unit which detects deterioration in the state of an optical signal that reaches the optical node device itself;

a unit which, when a detection result from the detecting unit indicates signal deterioration, recognizes that the optical node device itself is a 3R destination node, and also a 3R source node of a next 3R section; and

an updating unit which updates information of a 3R section the optical node device itself stores based on a recognition result.

69. An optical node device which, when a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, and an optical node device at an end point of an optical path is defined as a destination node, generates 3R section information in a route from the optical node device itself to the destination node, the optical node device comprising:

10 a transmitting unit which transmits an optical test signal each time an optical path is set for other optical node devices contained in the route from the optical node device itself to the destination node one hop at a time in order from a next hop adjacent optical node device;

15 a receiving unit which, each time the optical test signal is transmitted to the other optical node devices contained in the route to the destination node one hop at a time in order from the next hop adjacent optical node device by the transmitting unit, receives a report of deterioration in the state of the optical test signal from another optical node device at the farthest end which receives the optical test signal; and

20 a unit which, when the deterioration in the state of the optical test signal based on the report received by the receiving unit satisfies a predetermined deterioration condition, gives notification to another optical node device corresponding to one hop before the other optical node device at the farthest end that the other optical node device corresponding to one hop before the other optical node device at the farthest end is a 3R destination node, and also a 3R source node of a next 3R section,

25 wherein the other optical node device that receives the notification is provided with:

a transmission unit which transmits an optical test signal each time an optical path is set for other optical node devices contained in a route to the destination node one hop at a time in order from a next hop adjacent optical node device;

- 5 a reception unit which, each time the optical test signal is transmitted to the other optical node devices contained in the route to the destination node one hop at a time in order from the next hop adjacent optical node device by the transmission unit, receives a report of deterioration in the state of the optical test signal from another optical node device at the farthest end which receives the optical test signal; and

- 10 a unit which, when the deterioration in the state of the optical test signal based on the report received by the reception unit satisfies a predetermined deterioration condition, informs another optical node device corresponding to one hop before the other optical node device at the farthest end that the other optical node device corresponding to one hop before the other optical node device at the farthest end is a 3R destination node, and also a 3R source node of a next 3R section.

15

- 70. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, and an optical node device at an end point of the 3R section is defined as a 3R destination node, the optical node device comprising:

- 20 a setting unit which sets an optical test path from the optical node device itself to other optical node devices contained in a link to be measured, being a measurement object of 3R section information, one hop at a time in order from a next hop adjacent optical node device:

a transmitting unit which transmits an optical test signal each time the optical test path is set for the other optical node devices contained in the link to be measured one hop at a time in order from the next hop adjacent optical node device by the setting unit;

5 a receiving unit which, each time the optical test signal is transmitted to the other optical node devices contained in the link to be measured one hop at a time in order from the next hop adjacent optical node device by the transmitting unit, receives a report of deterioration in the state of the optical test signal from another optical node device at the farthest end that receives the optical test signal; and

10 a recognizing unit which, when the deterioration in the state of the optical test signal based on the report received by the receiving unit satisfies a predetermined deterioration condition, recognizes another optical node device corresponding to one hop before the other optical node device at the farthest end as a 3R destination node, and also a 3R source node, of a next 3R section.

15 71. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined 20 as a source node, and an optical node device at an end point of the optical path is defined as a destination node, the optical node device comprising:

a unit which stores a value Q, preset for each link based on optical signal deterioration characteristics in a link between the optical node device itself and an adjacent node;

a unit which, when the optical node device itself is a source node, transmits an initial value P of a minuend to a next hop adjacent optical node device;

a calculating unit which, when the optical node device itself receives from a previous hop adjacent optical node device, the initial value P or a minuend value P',

5 which has already been reduced from the initial value P, calculates (P-Q) or (P'-Q);

a unit which compares a calculated result of the calculating unit with a threshold value, and when the calculated result is greater than the threshold value, transmits the calculated result to the next hop adjacent optical node device, and when the calculated result is less than or equal to the threshold value, recognizes that the optical node device

10 itself is a 3R destination node when an optical node device that transmits the initial value P of the minuend is a 3R source node; and

a unit which, when it is recognized that the optical node device itself is a 3R destination node, and the optical node device itself is not a destination node of an optical path to which the value of the minuend is transmitted, transmits the initial value P of the

15 minuend to the next hop adjacent optical node device using the optical node device itself as a 3R source node.

72. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an

20 optical node device at a start point of the 3R section is defined as a 3R source node, an

optical node device at an end point of the 3R section is defined as a 3R destination node,

an optical node device, being a source of a setting request for an optical path, is defined

as a source node, an optical node device at an end point of the optical path is defined as a

destination node, an optical path directed away from the source node toward the

25 destination node is defined as a downstream optical path, and an optical path directed

away from the destination node toward the source node is defined as an upstream optical path, the optical node device comprising:

a detecting unit which detects deterioration in the state of an optical signal in the upstream optical path that reaches the optical node device itself;

5 a notifying unit which, when a detection result from the detecting unit indicates signal deterioration, notifies a next hop adjacent optical node device of the optical node device itself, that the next hop adjacent optical node device is a 3R destination node of the upstream optical path, and also a 3R source node of a next 3R section;

10 a unit which, when the optical node device itself receives notification from the notifying unit of a previous hop adjacent optical node device, recognizes that the optical node device itself is a 3R destination node of the upstream optical path, and also a 3R source node of a next 3R section; and

an updating unit which updates information of a 3R section the optical node device itself stores, based on a recognition result.

15

73. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node,

20 an optical node device, being a source of a setting request for an optical path, is defined as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, the optical node device comprising:

a detecting unit which detects deterioration in the state of an optical signal in the upstream optical path that reaches the optical node device itself;

a unit which, when a detection result from the detecting unit indicates signal deterioration, recognizes that the optical node device itself is a 3R destination node of the

5 upstream optical path, and also a 3R source node of a next 3R section; and

an updating unit which updates information of a 3R section the optical node device itself stores, based on a recognition result.

74. An optical node device which, when a preset section in which data transmission

10 is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end

point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical

15 path directed away from the source node toward the destination node is defined as a

downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, generates 3R section information in a route from the source node to the destination node, the optical node

device comprising:

20 a unit which, when the optical node device itself is a source node, sets an optical path for other optical node devices contained in a route to the destination node one hop at a time in order from a next hop adjacent optical node device;

a unit which, when the optical node device itself is not a source node, and when an optical path is set in the optical node device itself, transmits an optical test signal to

25 the upstream optical path;

a unit which, when the optical node device itself is a source node, receives the optical test signal, and give notification to a sender of the optical test signal of a report of deterioration in the state of the optical test signal;

a unit which, when the optical node device itself is an optical node device being

5 the sender of the optical test signal, and when the deterioration in the state of the optical test signal based on the notification satisfies a predetermined deterioration condition, recognizes that the optical node device itself is a 3R source node in the upstream optical path, and also a 3R destination node of a previous 3R section; and

a unit which, when the optical node device itself is an optical node device that

10 recognizes that the optical node device itself is a 3R source node in the upstream optical path, and also a 3R destination node of the previous 3R section, sets an optical path for the other optical node devices contained in a route from the optical node device itself to the destination node one hop at a time in order from the next hop adjacent optical node device, receives the optical test signal, and notifies the sender of the optical test signal of

15 the report of the deterioration in the state of the optical test signal.

75. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an

20 optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed

away from the destination node toward the source node is defined as an upstream optical path, the optical node device comprising:

- a unit which, when the optical node device itself is a source node, sets an upstream optical test path in other optical node devices contained in a link to be measured, being a measurement object of 3R section information, one hop at a time in order from a next hop adjacent optical node device;
- a unit which, when the optical node device itself is an optical node device in which the upstream optical test path is set, sends an optical test signal to the upstream optical test path;
- 10 a unit which, when the optical node device itself is a source node, receives the optical test signal, and notifies a sender of the optical test signal of a report of deterioration in the state of the optical test signal;
- a recognizing unit which, when the optical node device itself is an optical node device being the sender of the optical test signal, and when the deterioration in the state 15 of the optical test signal based on the report satisfies a predetermined deterioration condition, recognizes that the optical node device itself is a 3R source node in the upstream optical path, and also a 3R destination node of a previous 3R section; and
- a unit which, when the optical node device itself is an optical node device that recognizes that the optical node device itself is a 3R source node in the upstream optical path, and also a 3R destination node of the previous 3R section, sets an upstream optical test path in the other optical node devices contained in a link to be measured, being a measurement object of 3R section information, one hop at a time in order from the next 20 hop adjacent optical node device, receives the optical test signal, and informs the sender of the optical test signal of a report of deterioration in the state of the optical test signal.

76. An optical node device according to any one of claims 67, 68, 72, and 73, further comprising:

a unit which advertises the information of the 3R section updated by the updating unit to other optical node devices; and

5 a unit which receives an advertisement from the other optical node devices, and updates the information of the 3R section the optical node device itself stores.

77. An optical node device according to claim 70 or claim 75, further comprising a unit which stores a recognition result from the recognizing unit.

10

78. An optical node device according to claim 70 or claim 75, further comprising:

a unit which advertises a recognition result from the recognizing unit to other optical node devices; and

15 stores a recognition result contained in the advertisement together with a recognition result of the optical node itself device.

79. An optical node device according to claim 70 or claim 75, further comprising a unit which notifies a network control device which manages an optical network and stores 3R section information in the optical network, of a recognition result from the recognizing unit.

20 80. A network control device which, when a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node 25 device at a start point of the 3R section is defined as a 3R source node, and an optical

node device at an end point of the 3R section is defined as a 3R destination node, controls an optical network and stores 3R section information in the optical network, the network control device comprising a unit which receives information of the 3R destination node or 3R source node from an optical node device that configures the 5 optical network, and updates the 3R section information stored.

81. An optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an 10 optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed 15 away from the destination node toward the source node is defined as an upstream optical path, the optical node device comprising:

a unit which stores a value q , preset for each link based on optical signal deterioration characteristics in a link between the optical node device itself and an adjacent node;

20 a unit which, when the optical node device itself is a source node, transmits an initial value p of an augend to a next hop adjacent optical node device;

a calculating unit which, when the optical node device itself receives from a previous hop adjacent optical node device, the initial value p or an augend value p' , which has already been increased from the initial value p , calculates $(p+q)$ or $(p'+q)$;

a unit which compares a calculated result of the calculating unit with a threshold value, and when the calculated result is less than the threshold value, transmits the

calculated result to the next hop adjacent optical node device, and when the calculated result is greater than or equal to the threshold value, recognizes that the optical node

5 device itself is a 3R source node when an optical node device that transmits the initial value p of the augend is a 3R destination node in the upstream optical path; and

a unit which, when the optical node device itself recognizes that the optical node device itself is a 3R source node in the upstream optical path, and is not a destination node of an optical path to which the value of the augend is transmitted, transmits the

10 initial value p of the augend to the next hop adjacent optical node device using the optical node device itself as a 3R destination node in the upstream optical path.

82. An optical network that is provided with an optical node device according to any one of claim 64, claims 67 through 79, and claim 81, or with a maintenance-staff device
15 according to claim 62, or with a network control device according to any one of claims 61, 63, 65, 66, and 80.

83. A method of generating 3R section information in a route from a source node to a destination node, wherein a preset section in which data transmission is possible
20 without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device, being a source of a setting request for an optical path, is defined as the source node, and an optical node device at an end point of the optical path is defined as the destination node, the method comprising:

a first step of transmitting an optical test signal from an optical node device being the source node each time an optical path, is set for optical node devices contained in a route to the destination node one hop at a time in order from a next hop adjacent optical node device of the optical node device, being the source node;

5 a second step in which, each time the optical test signal is transmitted in the first step to the optical node devices contained in the route to the destination node one hop at a time in order from the next hop adjacent optical node device of the optical node device, being the source node, the optical node device, being the source node, receives a report of deterioration in the state of the optical test signal from an optical node device at the 10 farthest end that receives the optical test signal;

a third step in which, when the deterioration in the state of the optical test signal based on the report received in the second step satisfies a predetermined deterioration condition, the optical node device, being the source node, gives notification to an optical node device one hop before the optical node device at the farthest end that the optical 15 node device one hop before the optical node device at the farthest end is a 3R destination node, and also a 3R source node of a next 3R section;

a fourth step in which an optical node device which receives the notification transmits an optical test signal each time an optical path is set for optical node devices contained in a route to the destination node one hop at a time in order from a next hop 20 adjacent optical node device to the optical node device itself;

a fifth step in which the optical node device which receives the notification receives a report of deterioration in the state of the optical test signal from the optical node device at the farthest end which receives the optical test signal, each time the optical test signal is transmitted in the fourth step to the optical node devices contained in

the route to the destination node one hop at a time in order from the next hop adjacent optical node device to the optical node device itself; and

a sixth step in which, when the deterioration in the state of the optical test signal based on the report received in the fifth step satisfies a predetermined deterioration

5 condition, the optical node device which receives the notification informs an optical node device one hop before the optical node device at the farthest end that the optical node device one hop before the optical node device at the farthest end is a 3R destination node, and also a 3R source node, of a next 3R section.

10 84. A method of generating 3R section information in an optical node device that switches an optical signal, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, and an optical node device at a start point of the 3R section is defined as a 3R source node, the method comprising:

a seventh step in which an optical node device, being a 3R source node, sets an 15 optical test path to optical node devices contained in a link to be measured, being a measurement object of 3R section information, one hop at a time in order from a next hop adjacent optical node device;

an eighth step of transmitting an optical test signal, each time the optical test path is set for the optical node devices contained in the link to be measured one hop at a 20 time in order from the next hop adjacent optical node device of the optical node device, being the 3R source node, in the seventh step;

a ninth step in which the optical node device, being the 3R source node, receives a report of deterioration in the state of the optical test signal from an optical node device at the farthest end which receives the optical test signal, each time the optical test signal 25 is transmitted to the optical node devices contained in the link to be measured one hop at

a time in order from the next hop adjacent optical node device of the optical node device, being the 3R source node, in the eighth step; and

a tenth step in which, when the deterioration in the state of the optical test signal based on the report received in the ninth step satisfies a predetermined deterioration

5 condition, the optical node device, being the 3R source node, recognizes an optical node device one hop before the optical node device at the farthest end as a 3R destination node.

85. A method of generating 3R section information in an optical node device that

10 switches an optical signal, the method comprising:

a step in which a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a

15 setting request for an optical path, is defined as a source node, and an optical node device at an end point of the optical path is defined as a destination node;

a step in which each optical node device stores a value Q, preset for each link based on optical signal deterioration characteristics in a link between each optical node device and an adjacent node;

20 a step in which an optical node device, being a source node, transmits an initial value P of a minuend to a next hop adjacent optical node device;

a step in which each optical node device calculates $(P-Q)$ or $(P'-Q)$ when each optical node device receives from a previous hop adjacent optical node device, the initial value P or a value of a minuend P', which has already been reduced from the initial value

25 P, compares a calculated result with a threshold value, and when the calculated result is

greater than the threshold value, each optical node device transmits the calculated result to the next hop adjacent optical node device, and when the calculated result is less than or equal to the threshold value, each optical node device recognizes that the optical node device itself is a 3R destination node when the optical node device that has transmitted

- 5 the initial value P of the minuend is a 3R source node, and when each optical node recognizes that the optical node device itself is a 3R destination node, and when the optical node device itself is not a destination node of an optical path to which the value of the minuend is transmitted, each optical node device transmits the initial value P of the minuend to the next hop adjacent optical node device using the optical node device itself
- 10 as a 3R source node.

86. A method of generating 3R section information in a route from a source node to a destination node, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the

- 15 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as the source node, an optical node device at an end point of the optical path is defined as the destination node, an optical path directed away from the source node toward the destination node is defined as a
- 20 downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, the method comprising the steps of:

an eleventh step in which an optical node device, being a source node, sets an optical path for other optical node devices contained in a route to the destination node

- 25 one hop at a time in order from a next hop adjacent optical node device;

a twelfth step in which an optical node device that is not a source node transmits an optical test signal to the upstream optical path when an optical path is set in the optical node device that is not the source node;

5 a thirteenth step in which the optical node device, being a source node, receives the optical test signal, and informs a sender of the optical test signal of a report of deterioration in the state of the optical test signal;

10 a fourteenth step in which, when the deterioration in the state of the optical test signal based on the report satisfies a predetermined deterioration condition, the optical node device being the sender of the optical test signal, recognizes that the optical node device being the sender of the optical test signal, is a 3R source node in the upstream optical path, and also a 3R destination node of a previous 3R section; and

15 a fifteenth step in which the optical node device that recognizes that the optical node device itself is a 3R source node in the upstream optical path, and also a 3R destination node of the previous 3R section, sets an optical path for other optical node devices contained in a route from the optical node device itself to the destination node one hop at a time in order from a next hop adjacent optical node device, receives the optical test signal, and informs a sender of the optical test signal of a report of deterioration in the state of the optical test signal.

20 87. A method of generating 3R section information in a route from a source node to a destination node, wherein a preset section in which data transmission is possible without 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of 25 a setting request for an optical path, is defined as the source node, an optical node device

at an end point of the optical path is defined as the destination node, an optical path directed away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path, the method comprising:

- 5 a sixteenth step in which an optical node device, being a source node, sets an upstream optical test path in other optical node devices contained in a link to be measured, being a measurement object of 3R section information, one hop at a time in order from a next hop adjacent optical node device;
- 10 a seventeenth step in which an optical node device in which the upstream optical test path is set transmits an optical test signal to the upstream optical test path;
- a eighteenth step in which the optical node device, being the source node, receives the optical test signal, and notifies a report of deterioration in the state of the optical test signal to a sender of the optical test signal;
- 15 a nineteenth step in which, when the deterioration in the state of the optical test signal based on the report satisfies a predetermined deterioration condition, the optical node device being the sender of the optical test signal, recognizes that the optical node device, being the sender of the optical test signal, is a 3R source node in the upstream optical path, and also a 3R destination node of a previous 3R section; and
- 20 a twentieth step, in which the optical node device that recognizes that the optical node device itself is a 3R source node in the upstream optical path, and also a 3R destination node of the previous 3R section, sets an upstream optical test path for the other optical node devices contained in the link to be measured, being a measurement object of 3R section information, one hop at a time in order from the next hop adjacent optical node device, receives the optical test signal, and informs the sender of the optical test signal of the report of the deterioration in the state of the optical test signal.

88. A method of generating 3R section information in an optical node device that switches an optical signal, the method comprising:

a step in which a preset section in which data transmission is possible without

5 3R relay is defined as a 3R section, an optical node device at a start point of the 3R section is defined as a 3R source node, an optical node device at an end point of the 3R section is defined as a 3R destination node, an optical node device, being a source of a setting request for an optical path, is defined as a source node, an optical node device at an end point of the optical path is defined as a destination node, an optical path directed 10 away from the source node toward the destination node is defined as a downstream optical path, and an optical path directed away from the destination node toward the source node is defined as an upstream optical path;

a step in which each optical node device stores a value q , preset for each link based on optical signal deterioration characteristics in a link between each optical node 15 device and an adjacent node;

a step in which an optical node device, being a source node, transmits an initial value p of an augend to a next hop adjacent optical node device; and

a step in which each optical node device calculates $(p+q)$ or $(p'+q)$ when each optical node device receives from a previous hop adjacent optical node device, the initial value p or a value of an augend p' , which has already been increased from the initial 20 value p , compares a calculated result with a threshold value, and when the calculated value p , compares a calculated result with a threshold value, transmits the calculated result to the next hop adjacent optical node device, and when the calculated result is greater than or equal to the threshold value, recognizes that the optical node device itself is a 3R source node when 25 the optical node device that has transmitted the initial value p of the augend is a 3R

destination node of the upstream optical path, and when each optical node device recognizes that the optical node device itself is a 3R source node of the upstream optical path, and is not a destination node of an optical path to which the value of the augend is transmitted, each optical node device transmits the initial value p of the augend to the

5 next hop adjacent optical node device using the optical node device itself as a 3R destination node of the upstream optical path.